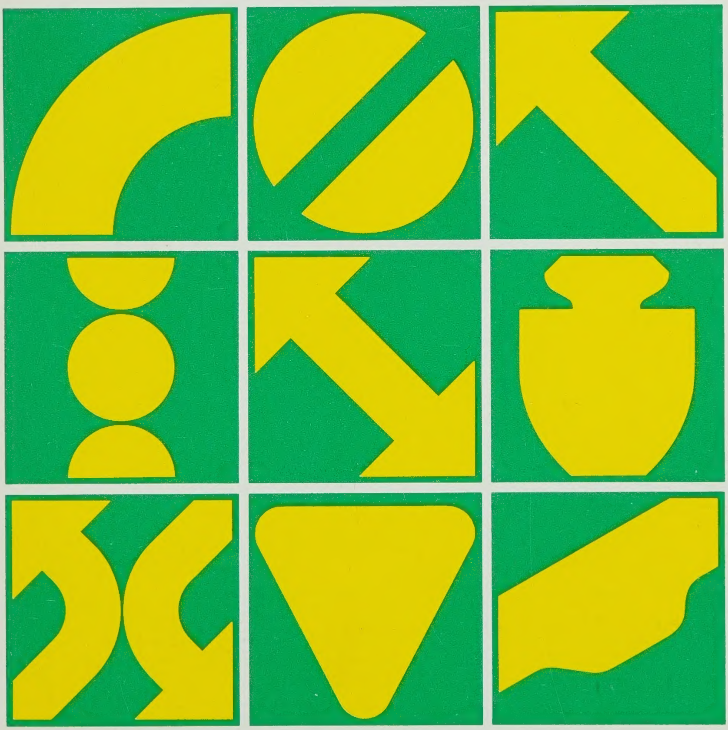
Energy conservation through traffic management

Energy
Ontario

Energy Conservation through Traffic Management

A Handbook of Municipal Opportunities



Energy Conservation through Traffic Management

A Handbook of Municipal Opportunities

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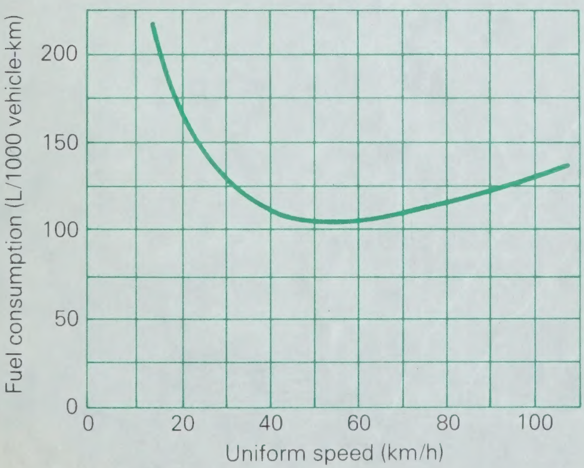
Energy and Transportation

Transportation swallows almost half of the oil consumed in Ontario, at an annual cost of over $4 billion. This mounting economic burden, together with serious questions about the security of supply, has put energy conservation in the transportation sector high on the list of Ontario government priorities.

While there is considerable scope for oil savings in inter-city transportation, it is transportation within municipal boundaries that offers the most immediate opportunities for major reductions. Because of greater travel density and choice of travel modes in our cities, significant reductions in oil consumption can be achieved relatively quickly — especially when a comprehensive management approach is taken.

With fully 35% of Ontario's transportation energy used for travel in built-up areas, it is clear that the implementation of appropriate municipal transportation initiatives is an essential component of Ontario's energy conservation program. But there are other compelling reasons for municipalities to implement these measures as well. In addition to improving safety and significantly reducing noise and air pollution levels, energy-efficient transportation systems reduce travel delay and save dollars. Money that would have bought foreign-owned oil can, instead, be kept in the local economy. Also, money that would have been needed to build costly new roadway capacity can be saved and applied to other municipal services. In short, energy conservation in municipal transportation is not only good for Ontario as a whole — it is also good for every town and city in the province.

Fuel Consumption at Various Uniform Speeds*



Traffic moving at uniform speeds minimizes fuel consumption, accidents, noise and air pollution.

The most fuel-efficient uniform speed is about 53 km/h.

* for light-duty vehicles

There are a number of energy-conserving transportation measures, all with large potential impacts, which are worthy of immediate municipal consideration:

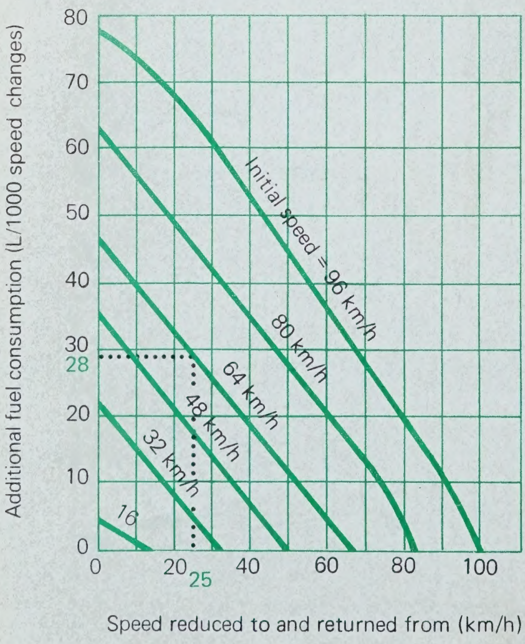
- transit improvements,
- incentives for other high-occupancy vehicles (e.g., car- and vanpools),
- enhancement of pedestrian and bicycle facilities,
- fleet management,
- improved roadway maintenance,
- appropriate traffic management techniques.

This booklet focuses on the latter measure because it is a natural first step in a municipality's transportation energy conservation program.

Traffic Management - A First Step

Generally, traffic management measures are intended to ease congestion and improve the flow of traffic. Such measures reduce stop-and-go driving and long periods of engine idling, both big energy wasters. In fact, every time a car is forced to stop and then accelerate back up to speed, about two cents' worth of extra gasoline is consumed. In a city of 100 000 people, traffic stops alone add up to an estimated two-million dollar annual drain on the local economy.

Additional Fuel Consumption Due to Speed Changes*



The aim of traffic management is to streamline the flow of traffic to minimize the negative impacts of speed changes, one of which is significantly higher fuel consumption.

For example, a traffic impediment requiring vehicles to change speed from 64 km/h to 25 km/h then back to 64 km/h will result in an additional 28.1 litres of fuel being consumed for every 1000 speed changes (compared to those vehicles continuing at uniform speed).

* for light-duty vehicles

Clearly, measures which succeed in streamlining the flow of traffic can produce significant energy savings. Such measures will usually have other benefits as well:

- reduced accidents,
- reduced travel times (and motorist frustration),
- reduced levels of noise and air pollution,
- improved environment for walking and sitting,
- possible deferral of capital expenditures for new roadway capacity.

Because traffic management measures are generally low-cost, well-received by the public and relatively easy to implement, they are often among the first energy-conserving steps a municipality takes. However, it is important that such measures not be the *only* conservation steps taken.

Traffic management measures, when implemented in isolation, can actually *waste* energy. Changes that make driving easier and more pleasant — as these measures do — increase the attractiveness of the car relative to such energy-efficient alternatives as public transit or ride-sharing. Consequently, traffic management *can* result in more people driving more cars (and thus using more energy) than would otherwise have been the case. A comprehensive management approach will avoid this problem by also implementing such measures as exclusive bus lanes, pedestrian and cycling facilities, parking restrictions and pricing policies to encourage the shift to more energy-efficient modes of transportation.

This booklet discusses a wide range of possible municipal traffic management measures, and points to important potential energy savings. For example:

- Computerized traffic control systems can save up to 20% of the energy consumed by any traffic directly affected. These systems are cost-effective for cities of 50 000 or more.
- Replacing stop signs with yield signs can save over 25% of the energy consumed at particular intersections.
- Widening intersections to create exclusive turn lanes can cut 20% from peak-hour energy consumption at the affected intersection.
- The establishment of reversible traffic lanes can save up to 15% of the energy consumed by the directly-affected traffic, without necessarily increasing accident frequency.

These measures, and the others described in this booklet, are not new. Most have long been part of the repertoire of municipal traffic engineers, serving as tools to reduce congestion. Now, however, energy conservation has become an important factor in traffic management decision-making. As energy prices rise, traffic measures that seemed premature a year ago may now be justifiable. In addition, as each city's or town's traffic patterns change (with the opening, say, of a new shopping mall), traffic management techniques need to be re-evaluated to ensure that they continue to meet local needs — including the need to conserve energy.

Implementation

The decision on which measures a municipality should actually implement requires site-specific analysis. The management measures described in this booklet give some indication of the projected benefits, but these are based on particular situations or theoretical models. Furthermore, the estimated energy savings are given as a percentage of the energy consumed by the directly-affected traffic only and thus do not serve as a good guide for comparing actual savings. Some measures affect significantly more traffic than others — for example, measure 'A' might produce a 20% saving where it is applicable, but it might be applicable at only three locations; whereas measure 'B' might produce only a 10% saving per location but be applicable at 40 locations.

The descriptions which follow *do* indicate some of the general points to be considered in planning traffic management initiatives. More detailed planning, however, requires a careful analysis of the specific local needs and the existing traffic conditions. Projections of the impacts of any proposed measures also need to be developed and assessed. With these data, the relative costs and benefits of different options can be compared, and the best identified. Technical support for this evaluation process is available to municipalities from the Ministry of Transportation and Communications (MTC).

There will be times when the most energy-conserving traffic management option will seem inappropriate. For instance, the legitimate concerns of community leaders and neighbourhood associations have led to the widespread adoption of 4-way stops and pedestrian crosswalks. Frequently, more energy-efficient alternatives (such as 2-way stops, yield signs and pedestrian-activated signals) will meet community needs — but there will always be circumstances where this is not the case. The key to honest resolution of such conflicts — whether apparent or real — is an effective process of public participation.

A growing number of Ontario municipalities are adopting energy-conserving traffic management measures, many with the active assistance of the MTC.

- The City of Brantford and the Regional Municipalities of Waterloo and Durham are installing computerized traffic control systems.
- Reversible lanes have been introduced in Durham and Toronto.
- Ottawa has long had bus bays along certain streets and roads.
- Durham Region (in co-operation with area municipalities) has completed a detailed review of stop control at all intersections.
- Hamilton and a number of other Ontario municipalities have introduced one-way street systems, added exclusive turning lanes and moved to control parking on arterials.

Clearly, those municipalities gaining implementation experience now will be well placed to reap major rewards in the future as the energy situation imposes ever-more-challenging constraints on Ontario's transportation system. The following pages describe how your municipality can begin or expand its efforts to conserve transportation energy.

Opportunities in Traffic Management

Signal Timing and Coordination

Using new technologies, traffic signals can now be timed and coordinated more effectively, resulting in significant energy savings.

Improperly-timed and unsynchronized traffic signals can aggravate congestion, cause needless stopping and force excessive idling — all of which waste energy. No matter how sophisticated the existing signal system, signal timings should be regularly re-evaluated.

For isolated traffic signals, adjustments can be made to the lengths of different phases of the cycle, and additional phases (e.g., a turn arrow) can be added. The net result can be less total stopping and idling by vehicles at the intersection.

For traffic signal systems, technological advances have added new capabilities and savings potentials. A mini-computer serving as master controller can be connected to a large number of local intersections. A range of pre-determined (but regularly revised) timing plans can then be implemented at different times of the day for selected groups of signals. The result is a well-synchronized and energy-efficient traffic flow.

Such sophisticated control systems are now cost-effective for communities of more than 50 000. Even communities with existing coordinated systems should consider upgrading, since technological advances can make significant further improvements possible — particularly where a system is hard to maintain and cannot be readily expanded.

The benefits of such coordinated signal systems include:

- a 4–20% reduction in the energy consumed by directly-affected traffic,
- a similar reduction in air pollution,
- an 8–40% increase in operating speeds,
- a possible reduction in accidents.

Less sophisticated improvements in signal timing and coordination can also yield significant benefits. As with any major improvement in city traffic flow, other measures (such as parking restrictions and exclusive lanes for high-occupancy vehicles) should be taken to ensure that the improvements do not result in increased use of low-occupancy automobiles.

Down-Signing

Traffic signals and signs can be downgraded in order to reduce the energy cost of stop-and-start traffic.

It takes energy for a car to idle at a stop signal, and it takes extra energy for that car to start up again. Any changes that reduce the number of stops or the total idling time will save energy. There are a number of options:

Four-way stops are particularly energy-wasteful and can be replaced by two-way stops (or three-way stops by one-way stops).

Stop signs can be replaced by yield signs, saving over 25% of the energy consumed at the stop. Still further savings can be realized by eliminating some of the yield signs.

Traffic signals on a fixed cycle can, at appropriate intersections, be replaced by flashing signals for at least part of the day. The use of a red flash in all directions is inefficient, but the use of a yellow flash on the main street and a red one on the cross street can produce significant energy savings.

Traffic signals can be replaced by stop signs if traffic volumes have declined. When 4-way stops are substituted, energy consumption actually rises, but if 2-way stops can be introduced, consumption will generally decline.

Crosswalks can be either eliminated or replaced by pedestrian-activated traffic signals. If they are eliminated, the energy consumed by directly-affected traffic can be expected to decline by about 10%. If new signals are chosen instead, and if they are integrated into a coordinated system, the energy savings will still be worthwhile.

Energy, of course, is not the only concern. With some of these measures, accidents may increase if the new signals or signs are introduced at the wrong intersection or in the wrong way. Advance assessment of this possibility and careful monitoring afterwards are essential elements of any implementation program.

Frequently, traffic control measures have been implemented principally to protect neighbourhoods. For instance, a series of 4-way stops may be installed to try to keep vehicle speeds at a safe level on residential streets or to divert traffic off such streets altogether. In other cases, traffic control measures are designed to protect and encourage pedestrians. These are all legitimate and important objectives — however, all reasonable ways of meeting them should always be considered.

Where traffic control measures are in place for reasons other than simple traffic control, these other concerns must be carefully responded to. In particular, community organizations and affected citizens must be fully involved in the decision-making process. Frequently, community needs and the goal of energy conservation are reconcilable. Yield signs may be as effective at controlling excessive vehicle speeds as 4-way stop signs. Pedestrian-activated traffic signals with a reasonably short waiting period may meet the same needs as a crosswalk. In short, there is usually no need to choose between neighbourhood protection and conservation — the two can co-exist.

Appropriate Traffic Control Criteria for Low Volume Intersections

Sight Distance	Accident history[1]	Major Roadway Volume (in vehicles per day) ≤2000	>2000	
Adequate	0	No Control		Control Measures[2]
	≤2		YIELD	
	3		STOP*	
	4		STOP	
Not adequate				

1. expressed in number of accidents in 3 years
2. measures include only 1- or 2-way systems.

* YIELD control is appropriate here if minor roadway volume is greater than 300 vehicles per day.

No significant differences in accidents are reported when control measures are reduced to the appropriate level (e.g., a stop sign replaced by a yield).

One-Way Street Systems

One-way street systems save energy by easing congestion and speeding the flow of traffic.

Clogged and congested street networks (particularly in downtown areas) result in significant vehicle delay and, consequently, in heavy fuel consumption. Where the street configuration allows, conversion of two-way streets to a system of one-way streets significantly reduces congestion and, as a bonus, allows important improvements in integrated signal timing.

Benefits realized from creation of a one-way network include:

- a drop of 5–25% in the energy consumed by the affected traffic,
- an increase in road capacity of 20–50%,
- a decline in air pollution of 5–25%,
- a reduction in the number of accidents.

In assessing the appropriateness of a one-way system in a given community, a number of factors must be considered. First, travel distances may be increased, offsetting some of the energy benefits of reduced congestion. The net energy effect should be calculated for each proposed system.

Second, improved traffic flow may encourage a greater shift to the private car than would be the case with some of the other, less extensive measures discussed in this booklet. Countermeasures, such as controlling the supply or raising the cost of downtown parking space, can offset this tendency.

Finally, the local business community may have concerns about the impact of the system change on their businesses. There is not strong evidence that this impact will, in general, be adverse. However, it is important to involve the business sector in the consideration and evaluation of any proposal, to ensure that the local impacts are acceptable.

Turning Lanes and Restrictions

Turning lanes and restrictions reduce energy wastage by easing congestion at intersections.

In heavy traffic, drivers wishing to turn left must often wait for a prolonged period of time for a break in the on-coming stream of vehicles. Similarly, drivers trying to turn right must often wait while a crowd of pedestrians crosses the intersection. While the turning vehicles wait, the through traffic lines up behind, using energy to sit and idle.

Two traffic management solutions are available. First, the approaches to intersections can be widened to create separate turning lanes, where turning vehicles can wait for an opening. Alternatively, turning restrictions can be applied — permanently or at certain times of day — thereby keeping traffic moving.

The benefits of intersection-widening include:

- a peak period saving of about 20% of the energy consumption at the intersection,
- a decline of about 5% in emissions,
- a drop in accidents and vehicle-delay.

Turning restrictions also bring important benefits, including:

- a reduction of 4% of the energy consumption at the intersection,
- a decline in congestion, accidents and emissions,
- protection of pedestrians.

Assuming there is sufficient turning volume to justify the introduction of turning lanes, the major constraint will be the availability of land and money. For turning restrictions, these constraints do not apply. However, it is important to assess, for each potential application, the possible increase in energy consumption caused by an increase in the total distance travelled (as a result of rerouting). In most circumstances, the net effect will be positive — but it will not always be so. In addition, the local impact of the rerouted traffic must be considered, particularly where it influences residential streets. The input from residents of adjacent areas could be an important factor in the decision-making process.

Bus Bays

Bus bays allow public transit vehicles to stop without obstructing the flow of traffic.

When buses stop in the street to take on passengers, the traffic behind the bus must also stop. During rush hour, buses are numerous, they stop often and they stop for long periods of time — as does the rush hour crush of vehicles caught behind them. Such stop-and-go traffic is disastrous from a fuel-economy point of view.

Bus bays are simply a short extra lane of road surface at bus stops. They allow public transit vehicles – and nothing else – to pull out of the traffic before stopping. Normally 3 m by 30–45 m (10 ft. by 100–150 ft.), bus bays can be established wherever there is available space. (Where space is not available, it may be worth relocating the stop.)

Where bus stops cause serious traffic disruptions, bus bays can:

- reduce peak-hour fuel consumption at affected intersections by 4%,
- reduce automobile travel time by 8–10%, and reduce travel time for transit vehicles (since they can gain access to the stop more quickly than would otherwise be the case),
- reduce emissions and accidents.

In assessing the appropriateness of bus bays, it is obviously important to work with the transit operator; otherwise, the analysis may be rendered useless by route changes, stop relocation, or increased or decreased frequencies.

Reversible Lanes

Reversible traffic lanes cut congestion and energy wastage by allowing the full use of available road space.

In urban areas during morning rush hour, the lanes entering the downtown area are usually clogged with traffic, while those leaving downtown are half empty. In the evening, the situation is usually reversed. By creating one or more reversible lanes, which accept inward-bound traffic in the morning and outward-bound traffic at night, congestion and energy consumption can be reduced.

Generally, reversible lanes deserve consideration by cities of 100 000 or more. They are normally implemented on a street with 3 or more lanes, so that at least one lane flows in each direction at all times. It is, of course, possible to reverse an entire street, regardless of width. While the task is more complex, the results can be very favourable indeed.

Reversible lanes improve conditions for traffic flowing in the peak direction. Although the off-peak direction may be adversely affected, the net effect is positive, resulting in a:

- 10–15% reduction in energy consumed by the affected traffic,
- 10–15% drop in vehicle emissions,
- 15–25% reduction in traffic delay.

As is the case for many of the measures in this booklet, increases in automobile use could result from the implementation of reversible lanes, since car travel would become faster and more convenient. This tendency should be countered through other measures that serve as disincentives to the use of single occupant automobiles (such as exclusive lanes for buses and other high-occupancy vehicles.)

Reversible-lane roadways often require restrictions on parking and left turns, particularly if the off-peak direction is confined to a single lane. They also require the cooperation of any affected groups, including the transit operator, the police, emergency vehicles and local residents or businesses. Finally, safe implementation of reversible lanes obviously requires extensive signage and an intensive initial publicity campaign.

Other Measures

Energy-wasting congestion and needless travel can be eased by various other measures.

There are many other traffic management measures, ranging from the simple to the complex, that can be introduced in built-up areas. The following examples illustrate this range.

Street signs that are small, poorly maintained, or not easily seen help people get lost — resulting in unnecessary travel and energy wastage. Larger lettering, standardized locations and an unobstructed view of the signs can help reduce this problem in any urban area, but especially in cities of over 100 000 people. Similarly, improved identification of highway routes through urban areas can reduce the amount of gasoline wasted by lost motorists.

Parking restrictions on busy streets, particularly during peak hours, have obvious potential to reduce congestion and wasteful stopping. With effective enforcement, energy savings will result. Furthermore, in some cases the restrictions may have a positive spin-off effect: by restricting parking availability, a shift to public transit and other higher-occupancy vehicles can be encouraged.

Freeway traffic management is appropriate in such large cities as Toronto, Ottawa and Hamilton, where expressways flow through the urban area. Appropriate measures include such obvious actions as rapid response to accidents or breakdowns (to remove blockages to traffic flow) provision of up-to-the-minute radio traffic reports and the use of changeable signs (to enable motorists to avoid congested routes). More elaborate measures include such things as ramp control, whereby cars are allowed to enter the freeway only at a fixed rate. Excessive congestion of the freeway can thus be prevented, leading to energy savings and accident reduction.

Summary of Measures

Measure	Energy impact* (decrease in consumption)	Relative costs
Improved signal timing	6%	Low
Coordination of traffic signals	5 – 20%	Medium to high
Replace signs and signals	Decrease	Low
Flashing of signals	Decrease	Low
Crosswalk replacement	10%	Low
One-way street systems	5 – 25%	Low to medium
Widening of intersection	20%	Low to medium
Turning movement restrictions	4%	Low
Bus bays	4%	Low to medium
Reversible lanes	8 – 10%	Low
Improved street signing	Decrease	Low
Improved route identification	Decrease	Low
Freeway control	8 – 10%	High

* impact on traffic directly affected only.

A Joint Effort

The Provincial government is doing its part too. A Transportation Energy Management Program has been created and is administered by the Ministry of Transportation and Communications in cooperation with the Ministry of Energy. This program contains a number of conservation initiatives: *Drive Propane*, *DriveSave*, for promoting fuel-efficient driving; *Trucksave*, for promoting truck energy conservation; and *Audio Teleconferencing*, promoted as a substitute for travel.

The vigorous *Municipal Energy Program*, in addition to supplying funding for innovative municipal conservation measures and conducting demonstration projects on provincial roadways in a number of municipalities, provides technical support and information for municipal efforts in the transportation energy management area. With both the provincial and municipal levels working together in a coordinated fashion, significant energy savings will be achieved in a few short years.

For municipalities requiring more information on the measures discussed in this booklet, or on any aspect of energy conservation in urban transportation, help is available from the Ontario government.

- **The Transportation Energy Management Program (TEMP)** is a provincial program concerned with the reduction of oil dependence in the transportation sector. For information, write to: TEMP, Ministry of Transportation and Communications, 1201 Wilson Avenue, Central Building – 3rd Floor, Downsview, Ontario M3M 1J8. Telephone: (416) 248-7296.
- **The Municipal Transportation Energy Advisory Committee (MTEAC)** was established to provide guidance, technical assistance and coordination to municipalities undertaking conservation programs. For information, write to: Mr. Frank Cherutti, Executive Secretary, MTEAC, 1201 Wilson, Avenue, Central Building – 3rd Floor, Downsview, Ontario M3M 1J8. Telephone: (416) 248-7296.
- **Traffic Management Measures to Reduce Energy Consumption** (August 1981) is the detailed IBI report upon which this summary booklet is based. Available from TEMP (address above).
- **Transportation Energy Analysis Manual (TEAM)** (available from MTEAC, Spring 1982) is a comprehensive summary of a wide range of diverse conservation measures in the following areas:
  - street system improvements,
  - transit service improvements,
  - ride-sharing,
  - demand management,
  - fleet management,
  - road construction and maintenance,
  - contingency planning.
- **Traffic Engineering Office, MTC,** provides advice on traffic control devices and operations. For information, write: The Manager, Traffic Engineering Office, MTC, 1201 Wilson Avenue, Central Building – 2nd floor, Downsview, Ontario M3M 1J8. Telephone: (416) 248-3781.

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